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Agricultural Patents: Are They Developing Bad Habits?

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Most observers agree that patents have helped private enterprise develop new technologies. Without patent protection, private companies might not recover development costs on new technologies that improve the performance of tractors, irrigation equipment, pesticides, storage facilities, and other inputs. U.S. companies have led the world in the development of these agricultural technologies. For the last several decades, patents clearly have provided helpful incentives to innovation.

The number of plant biotechnology patents granted by the U.S. Patent and Trademark Office (PTO) grew exponentially between 1990 and 2001 (Graff et al., 2003). This period coincided with fundamental revolutions in how agricultural technologies were developed. As agricultural technology has become more science-based, patents on platform and enabling biotechnologies, transformation and gene-transfer techniques, and methods for genomics research have strongly influenced the development of new technologies.

Patents pose a tradeoff between creating incentives for research and development (R&D) and the social costs of monopoly. Although patents provide research incentives over the length of the patent, they can impose social costs by granting monopoly profits and restricting or diverting the direction of technological change. Effects on productivity or efficiency and excessive industry concentration are important examples of unintended consequences. Patents may also limit access to discoveries through hold-ups and can lead to complex legal thickets when negotiating multiple licenses.

Here we consider how changes in patent law from the 1980s have affected innovation and the use of intellectual property (IP), with emphasis on agricultural biotechnology. Do the old IP rules still hold? Are patents still a good way to stimulate innovation when they convey monopoly protection to a technology that might otherwise find widespread application? Do patents express undesirable traits?

Patents on Living Organisms

In 1972, Ananda Chakrabarty, microbiologist at the University of Illinois at Chicago, applied for a patent on a genetically modified bacterium that enabled the breakdown of crude oil. His idea was to license the bacterium to groups responsible for cleaning oiled beaches after a spill. The PTO rejected the application on the grounds that living things could not be patented. The case reached the Supreme Court in 1980 after an appeals court reversed PTO's decision. The Supreme Court found that "everything under the sun that is made by man is eligible for patenting" and awarded Chakrabarty a patent on the bacterium.

In the years that followed, PTO issued hundreds of patents on plants and animals that as of 1985 resembled standard utility patents on pharmaceuticals or electronic devices. Utility patents cover the plants themselves, seeds, breeding methods, and plant biotechnology (Janis & Kesan, 2001). The Chakrabarty decision, in addition to accommodating the high-tech direction of agricultural R&D, provided fairly strong patent protection for important aspects of agricultural innovation.

Two complementary patent laws dealing with agricultural IP were already on the books. In 1930, Congress protected the nursery industry from competing firms that could take cuttings from plants to produce identical asexually reproduced competing products. Duplication of protected varieties from seeds of sexually reproduced plants was protected in 1970 by the Plant Variety Protection Act (PVPA), which was extended to include tuber-reproduced varieties in 1996. PVPA protection is limited by a research exemption and farmers' right to save seed "for use on the farm" (Janis & Kesan, 2001, p. 1163).

Whether these three forms of IP protection could co-exist was decided in 2001 when J.E.M. Ag Supply tested the validity of Pioneer Hi-Bred's overlapping patents on seed corn. Pioneer sells seeds in Iowa and elsewhere through authorized dealers. Each bag of seed has a license label printed on it stating that the seed can only be used for crop production. Pioneer has patents on both the inbred and hybrid corn lines that are produced by seed growers from the inbred lines.

J.E.M. contended that its distributor, Farm Advantage, had not violated Pioneer's patents when they sold unauthorized bags of seed corn in north central Iowa. J.E.M.'s defense was a broad argument that Pioneer's patents were not valid because the seeds themselves were already protected by PVPA. J.E.M. lost this argument in trial court, in the Court of Appeals, and in a Supreme Court review that upheld the lower court rulings (Janis & Kesan, 2002).

In the J.E.M. case, the Supreme Court had addressed only the narrow question of whether plants were eligible for utility patent protection—leaving many questions for future trial courts to decide. Included were non-obviousness of the innovation and full disclosure of its details that are also required for utility patent protection. A Court of Appeals for the Federal Circuit has recently been established to consider all cases of patent infringement and validity. Observers predict that the Court's rulings will apply consistently across disciplines, thus strengthening patent protection. Preliminary injunctions, which block the use of patented material while trials proceed, have increased dramatically (Lanjouw & Lerner, 2001).

Stronger patents, broad coverage, and consistent application might explain the surge in patenting since 1990. The growth in high-tech biotechnology has also stimulated patenting activity. However, there are other factors at work, which will be considered in the next sections.

A Slightly Bad Habit

When an innovator applies for a patent, the innovation details are revealed to the PTO. When the patent is granted, those details become public information. Competitors then learn what they cannot copy and may even attempt to negotiate a use license from the patent holder. Learning how the innovation was made, however, may help to create other innovations—some of which may compete with the patented product. The entire innovation is freely available for copying once the patent expires. If an innovation is difficult to copy, an innovator might choose trade secret protection, which is more limited and controlled at the state level, and choose not to apply for a patent in order to avoid revealing information.

More innovation is generally preferred from society's point of view, but patents have social tradeoffs. The social benefit of learning the details of an innovation (and some of how it was created) has to be weighed against the social cost of keeping that innovation locked up (if the innovator chooses not to license it) during the patent term (minus what is learned about creating new ones). Less-than-full disclosure is how some innovators protect against the use of their secrets by others. As the agricultural innovation process has become more high-tech, these problems have become more noticeable.

A commonly used method for freeing technologies from patent lock-up is nonexclusive licensing. Although exclusive licenses are common and are more marketable, they simply transfer patent lock-up from one owner to another. Partial and limited exclusivity has been sufficient in the public sector for attracting technology developers, but most Agricultural Research Service licenses are exclusive (Rubenstein, 2003).

There is limited popularity for any licensing, even after the Bayh-Dole Act of 1980 began to allow universities and small businesses to seek patents on their federally funded research. The Act also authorized federal agencies to grant exclusive licenses for federally owned patents.

Legislation to stimulate technology transfer from the public sector is not in short supply. The Stevenson-Wydler Act of 1980 focused on federal labs, and the Small Business Innovation Development Act of 1982 earmarked 1.5% of federal extramural research funds for small businesses. The National Cooperative Research Act of 1984 provided antitrust protection for companies, and the Federal Technology Transfer Act of 1986 established federal-private Cooperative Research and Development Agreements (CRADAs).

A More Serious Habit: Strategic Hold-Ups

A factor constraining widespread use of licenses is that some broad patents have been issued on a spectrum of technologies that may be the most likely sources of new gene transfer platform and enabling technologies. Broad patents may lead to expensive licenses or patent hold-ups where the inventor acts strategically to cut off the efforts of other developers. Patent holders might do this to gain time for their own research or to maintain exclusivity. Hold-ups are like lock-ups in that no licensing takes place. However, research hold-ups and strategic blocking are a more serious social problem, because avenues of research are closed off. Hold-ups are common in other fields as well, but it is difficult to "invent around" broad patents in biology (Rai, 2003). In medical biological research, DuPont holds an exclusive license on the Harvard Oncomouse; few firms have paid the licensing fee (Rai, 2003). Scientists have also reported problems with access to the few stem cell lines "acceptable" for research funded from federal sources (Holden & Vogel, 2002).

Only a few enabling technologies have been used in agbiotechnology—this might also indicate an innovation bottleneck. The two most common methods for transformation of plants are the gene gun and Agrobacterium. The gene gun involves firing an air-driven shotgun at the plant to be transformed. Microscopic shotgun pellets are coated with genetic material and the scientist sifts through remnants of the plant for cells that have the inserted genes. The more sophisticated technology uses *Agrobacterium tumefaciens*, a common soil bacterium that causes tumors near the junction of the root and stem of numerous dicots (plants that have seeds with two halves). Tumorous plant cells containing genetic material from the bacterium are used to infect genetic material into plants.

Much of the research on Agrobacterium-mediated transformation occurred at public institutions, but the private sector now holds the key patents on the technology. Companies gained control of this important transformation method through licensing and incremental internal research (Roa-Rodriguez & Nottenburg, 2003). The limited availability of methods for transforming plants might indicate some degree of patent hold-up on plant transformation technologies.

A biotechnology developed at the University of Chicago creates an artificial chromosome that can be stacked with designer genes, which the developer (Dr. Preuss) hopes can be used in plants to help control multiple-gene expression (Van, 2004). Mich Hein—chief executive of Chromatin, Inc., the company Preuss founded to develop the technology—has indicated that he has had "constant" difficulties obtaining licenses to apply the technology to specific crops (Hein, 2004).

Another Serious Habit: Patent Thickets

When licenses are available but a technology requires use rights from multiple institutions covering several patents it is known as a *patent thicket*. Companies frequently cite transaction costs (including regulation and record keeping) as limiting widespread licensing of technology. The recent development of Vitamin A "Golden Rice" required hacking through a patent thicket and negotiating licenses on 70 patents originally held by about 30 different institutions. This technology to improve nutrition in developing countries has not yet made it to market.

The transaction cost problems are compounded when licensing the rights to fragmented basic research platforms with parts owned by different companies. The problems may not be solved by market power, even though it might allow firms the time and resources to solve difficult research problems; individual companies (or even private consortia) may not see all potential avenues for improving basic research. By developing multiple technologies, different companies may end up competing with each other. Recent PTO guidelines on utility patents have moved to restrict patent scope (length and breadth) which some commentators, responding to the guidelines on the PTO website, assume will reduce patent applications on gene fragments often identified as important through genome mapping but of unknown (or uncertain) function (PTO, 2001). The tradeoff from breaking down the broad-patent problem may be an increase (possibly temporarily) in patent thickets. Eventually thickets might be reduced by licenses on groups of patents for a specific purpose. The challenge that this might raise for policymakers could be whether to promote licensing in addition to technology transfer.

The International Dimensions of Agricultural Patents

Other industrialized countries have been slower than the United States to grant patent protection on living organisms. A breakthrough occurred in 1999, when the European Patent Office began to grant patents on genetically engineered crops. Similar to utility patents and PVPA certificates in the United States, international IP is protected by the World Trade Organization's (WTO) Trade-Related Aspects of Intellectual Property (TRIPS) agreement and the International Union for the Protection of New Varieties of Plants (UPOV). TRIPS establishes a timetable for WTO members to harmonize their patent systems without requiring adherence to one set of patent laws. TRIPS presents a menu of IP options that members can adapt to local conditions. Harmonization even occurs at different rates, with developed countries expected to comply in one year, developing countries in five years and least developed countries in 11 years.

Although they strengthen farmers' rights to save seeds, extend protection to landraces, and provide other benefits to indigenous people, these international agreements experience severe problems. Many countries lack the bureaucratic infrastructure to maintain the records and staff necessary for a functional IP system. International agricultural research centers and national agricultural research systems face the challenge of developing greater capacity to negotiate and manage IP resources under budget constraints and high staff turnover.

Alleviating Thicket Problems

Several recent initiatives have addressed the information dissemination and technology accessibility problems. Chakrabarty, who won the first patent on a living organism, is chief scientific advisor on a project to develop an international science court for biotechnology and other rapidly developing scientific areas. The Einstein Institute for Science, Health, and the Courts (a nonprofit organization based in Bethesda, Maryland) is promoting the initiative (Nosengo, 2003).

Also in the Washington, DC area, the Economic Research Service (an agency of the USDA) is cooperating with Rutgers (the State University of New Jersey) with funding from USDA's extension service (CSREES) to create a classification system for agbiotechnology patents. They are creating a web-based, searchable database of PTO utility patents (and some related firm information) issued on biotechnology and other biological processes in food and agriculture between 1976 and 2000 (see http://ers.usda.gov/Data/biotechpatents/). The goal is to combine this database with international patent databases, such as the one being created with partial funding from the Rockefeller Foundation by the Center for the Application of Molecular Biology to International Agriculture (CAMBIA) in Australia.

Probably the most ambitious project is by the University of California at Berkeley. Several agricultural economists are working to combine IP informatics services (which include databases constructed before those just mentioned) with online patent exchanges. This IP clearinghouse, known as PIPRA (Public IP Resource for Agriculture), might create industry-specific collective rights organizations that can free up agricultural research for industry, academia, and international development. The desired outcome is to reduce the knowledge gaps and roadblocks that have altered the speed and direction of agricultural technological innovation.

For More Information

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